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Luncheon Address by
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It is a pleasure to take part with so many representatives of industry and the Armed Services in this Symposium on Engineering for Space. Your society has performed outstanding service toward increasing the technological potential of the United States. The S. A. M. E. recognizes that the national interest requires vigorous engineering activity at all times -- in peace, in war, and in a period like the present which is neither.

Engineers play vital roles in a new aspect of our national life, one that has important military as well as civilian aspects. I refer, of course, to the National Space Program and, particularly today, to the development and construction of the large, complex facilities for that program -- facilities that will support the quest for knowledge and exploration of the solar system in times of peace -- facilities that are also there to serve the Nation if aggression should threaten us.

Later, I shall touch upon some of the very large and complex installations we must construct if we are to achieve the objectives of the National Space Program.

First, however, let me sketch the background and growth of large-scale United States scientific and technological endeavors.

Since the early days of our independence, the Government role in science has been debated frequently. Persistently throughout the first 150 years of our national existence, Congress was reluctant to invest more than token sums in scientific research.

Government participation in science and technology grew slowly. In 1807, we created a bureau that was to become the U.S. Coast and Geodetic Survey. In 1846, the Smithsonian Institution arrived on the scene. The War between the States was the backdrop for the establishment of the National Academy of Sciences in 1863.

By the turn of the century, as science and technology in general gained momentum and scope, Congress established the National Bureau of Standards (in 1901) to pursue the science and technology of measurements, study materials, and solve related problems.

It was war, the First World War, that focused the Nation's attention on the need for greater Government scientific activity.

The pioneer aviation work of the Wright Brothers and Samuel P. Langley had been largely overlooked or ignored in this country. We entered World War I with neither design experience nor manufacturing capability in aeronautics. Congress recognized this deficiency in 1915 by creating the National Advisory Committee for Aeronautics.

Also during the First World War, the United States supported to a modest extent a Massachusetts physicist, Robert H. Goddard, in his studies of rockets as means of propulsion to reach "extreme altitudes." Goddard's work was underwritten by the Smithsonian Institution and the Army Signal Corps. During the war, Dr. Goddard made good progress in solving some of the basic problems of rocketry. The Smithsonian continued to furnish modest support in the 1920's.

On the whole, however, Federal participation in science and technology lagged between the two World Wars.

World War II brought about great and rapid expansion of Government participation in the fields of science and technology. We improved our aircraft. We developed radar. We applied electronics to military requirements, and for the same purpose investigated jet propulsion and resumed interest in rockets.

Overshadowing these projects was the unprecedented, secret investment of two billion dollars to achieve nuclear fission for military use. The success of this endeavor was a dramatic demonstration of what the United States can accomplish when it marshals its resources and the power of modern science to achieve a great national objective.

Following demonstration of the power of nuclear energy, Congress -- after full debate -- created the Atomic Energy Commission in 1946 and the National Science Foundation in 1950.

In 1955, the Nation resolved to launch at least one satellite during a special 18-month period to begin in 1957, established by world scientific organizations as the International Geophysical Year.

But when 1957 arrived, it was the Soviet Union that launched the first manmade earth satellite. Sputnik I was the first of a long series of demonstrations that the Soviets are able to carry out significant tasks in space, the newest and most dramatic arena of human activity and aspiration.

Soon after the first Sputniks orbited in the summer of 1958, Congress created the National Aeronautics and Space Administration (NASA), and an entire new sphere of Federal activity.

As the Space Act required, a long-range plan for the Nation's space program was drawn up. Meanwhile, the Soviet Union continued its succession of accomplishments. The question arose: was our program bold and far-reaching enough to contribute, in the language of the Space Act, to "the preservation of the role of the United States as a leader in aeronautical and space science and technology."

In the first weeks after President Kennedy took office, the Soviet demonstrations mounted in a crescendo, with the lifting of a 14,000-pound payload into orbit, the launching of a spacecraft toward Venus, and the manned orbital flight of Yuri Gagarin.

These new circumstances demanded a national space program of greater urgency and more ambitious goals.

A year ago this week, on May 25, 1961, President Kennedy declared it was "time for this Nation to take a clearly leading role in space achievement." He proposed accelerating and expanding the national space program in a number of significant areas.

The President's most arresting proposal was that the United States set as a national goal the landing of a team of U.S. explorers on the moon, and their return to earth before 1970. Under the previous plans, such a flight could not have taken place before the middle of the 1970's.

Congress endorsed the President's program in a non-partisan manner and, as you know, these undertakings are now well under way.

Our space activities are in no sense attempts to perform stunts -- spectaculars, if you will -- nor will the landing of U.S. astronauts on the moon be our ultimate objective. Rather, the national effort is organized on a broad basis to accomplish rapid advances in science and technology that will make it possible for us to carry out any assignment in space that the national interest might require. Furthermore, we plan that lunar exploration will lead to wider exploration of the solar system, ventures whose end no man can foresee.

The primary requirement of space activity is rocket power. In these two words are embodied the secret of Soviet success to date. The 14,000-pound satellite launched by the Soviets more than a year ago, in February 1961, was about five times as heavy as our Mercury spacecraft. The rocket vehicle that launched it must have had almost three times the power the largest booster we have now -- the Atlas-Agena B. And we have the word of Academician Anatoly Blagonravov before an American television audience that even more powerful Soviet launch vehicles are being developed.

The United States has established a National Launch Vehicle Program to develop the rocket power we require. At present, the program consists of 10 vehicles of varying sizes. Responsibilities for developing the vehicles are assigned to the National Aeronautics and Space Administration and the Department of Defense. Each vehicle, however, will be available to all agencies of the Government with work to do in space.

There is not time today to describe these launch vehicles in detail, but I do want to give you a feeling for what is involved.

The five smallest vehicles are already in use. They range from the Scout, which can lift 150 pounds into an earth orbit, to the Atlas-Agena B, which can orbit 5,000 pounds and last month launched the 750-pound Ranger 4 to the first landing of an American-made object on the moon.

We will have still more powerful launch vehicles in the next few years, such as Titan II which can orbit 6,000 pounds and will launch our two-man Gemini spacecraft into earth orbit, and the Centaur which can orbit 8,500 pounds and will make it possible to send more than half a ton of instruments to Mars.

The next rocket up the scale is the Saturn, the most powerful rocket vehicle, so far as the world knows, launched into space to date. We have conducted two highly successful flight tests of the Saturn first stage. Next year we plan to test-launch the second stage of Saturn. It will benefit from pioneering research in the Centaur program with liquid hydrogen fuel, which must be maintained at a temperature of 423° below zero Fahrenheit, and has other most difficult technical problems involved.

This first full-scale model of the Saturn will have thrust enough to boost a 10-ton version of the three-man Apollo spacecraft into orbit about the earth on scientific research and training flights leading to manned voyages to the moon.

The Advanced Saturn is the most powerful U.S. launch vehicle under development. It will be a completely new rocket with a first stage consisting of five engines, each as powerful as all eight engines of the present Saturn. When the Advanced Saturn is operational in four or five years, it will be able to lift 100 tons into earth orbit or to speed more than 40 tons to the vicinity of the moon.

Advanced Saturn will be powerful enough to launch the Apollo spacecraft on a flight around the moon. The thrust will not be sufficient, however, to carry to the moon both the Apollo spacecraft and the rockets required for descent to the surface and a launching back to the earth.

For direct flight to the moon and return, we are carefully analyzing the requirements for a giant among giants, the launch vehicle we call Nova. As envisioned at present, Nova would enable us to lift about 200 tons into earth orbit or dispatch 75 tons to the neighborhood of the moon. Nova will be a general purpose vehicle, providing efficient means of transporting heavy payloads to the moon and into space during the period after the first lunar landings.

Nova will also make it possible to launch large, manned orbital stations for any task the national interest may require. We plan to begin Nova development within 12 months.

Because long lead time is required for Nova development, we are investigating means of carrying out the landing on the moon with the Advanced Saturn. If we can perfect the technique of rendezvous and joining two objects together in space, we may achieve the lunar landing two years sooner than with the Nova direct ascent approach.

The application of nuclear energy to rocket propulsion may be another possibility. If a workable rocket engine can be developed, there is a possibility that we can land men on the moon, using an Advanced Saturn with a nuclear upper stage. We are pressing forward with nuclear rockets in any case, because they hold promise of solving propulsion problems of the next decade. The ultimate rocket we can now foresee is Nova with a nuclear-powered upper stage.

As I mentioned earlier, large and complex facilities are required to support the development of large launch vehicles. These facilities involve an investment that is not dissipated in the year for which the money is appropriated. They are national assets of lasting worth -- physical plant capacity that will augment our technical capacity for many years.

During the period of building toward a level of effort that will achieve the space goals established in 1961, investment in facilities will be heavy. Later, as the pace of research and development increases, the facilities investment will tend to taper off.

It is probably not news to this audience that construction of ground facilities is a critical pacing item in large rocket-development projects. Before rocket engines can be tested, we must build sizeable test stands. We must build still larger stands to test the rocket vehicle stages. Finally, a giant launching complex will be required at Cape Canaveral.

The advanced Saturn is a case in point. The F-1 rocket engine that will power the first stage has been under development for almost four years. The F-1 engine development contact was one of the first awarded by NASA, a few months after the agency was established in late 1958. Test facilities for the F-1 engine are in use at Edwards Air Force Base, in California. When the F-1 research and development program is completed, however, the engines must be built in production quantities and additional test facilities will be required.

The situation is similar with regard to the J-2, a high thrust liquid hydrogen engine that NASA began developing in 1960. The J-2 will be employed in the second and third stages of the Advanced Saturn. There are facilities for the research and development tests at an installation operated by a contractor in Santa Susana, California, but for larger production additional tests facilities must be constructed.

Next, we require facilities for building and testing the vehicle stage. For fabricating the first stage, the Government fortunately owns a large plant near New Orleans, at Michoud, recently transferred to NASA from the Army. In Southwestern Mississippi, across the Mississippi River from New Orleans, we are constructing stands for testing the first stage.

This is an enormous engineering job. The Advanced Saturn stage, consisting of five F-1 engines, exerts an upward thrust of seven and a half million pounds. You must dig deep into the ground to build foundations that will withstand that much force. One of the trickiest problems in the design of these large test stands is cooling the concrete and steel blast deflector. We must pump water at the rate of a half-million gallons a minute, carefully spraying every portion of the surface.

The test stand will be in operation at the Mississippi site by 1965, when the Advanced Saturn stages go into production. Meanwhile, we are saving time in research and development of constructing an Advanced Saturn stand at Marshall Space Flight Center in Huntsville, Alabama, which will be ready for use in about 12 months.

For the second and third stages of the Advanced Saturn, we plan to employ and improve facilities operated by contractors at various locations in California.

Without its payload, the Advanced Saturn will stand about 275 feet tall, a few feet shorter than the Capitol. If we stood an Advanced Saturn carrying an Apollo lunar spacecraft next to the Capitol, the astronauts would be able to look down on the Statue of Freedom crowning the dome. But the Advanced Saturn launching tower is even taller -- about 35 stories high.

NASA is planning to employ a new concept in launch facilities for the Advanced Saturn. Today, assembly of space vehicles takes place at the launch pad. The process takes weeks, sometimes months, what with the checking of all components and subsystems of the rocket-spacecraft combination. Obviously, time at the launch pad severely limits the number of vehicles we can launch.

To carry out rendezvous and cocking operations in space, we must be able to launch the Advanced Saturn on a rapid-fire basis. Thus, more than one launch complex must be built. Our studies indicate that four conventional Advanced Saturn launch pads would be necessary for proper support of rendezvous and docking.

However, we are investigating another solution. Instead of building four complexes, in which much expensive equipment would be duplicated, we are planning to employ a concept under which the vehicles would be assembled in a central building more than a mile away from the launch pad and would remain on the pad only a day or two. The vehicle and its access tower would be mounted on a mobile platform inside the building, where most of the time-consuming checkout would take place. The entire assembly would then move to the pad a day or two prior to the launch.

Preliminary studies indicate that this vertical assembly structure would have a high-bay area as tall as a 46-story building, about as wide, and longer than two football fields. Attached would be a low-bay area as tall as a 20-story building and slightly smaller in floor area. This building would provide facilities for simultaneous work on six Advanced Saturns, at a cost that would not exceed that of four conventional launching complexes. All together, the structure would have greater total volume than the Empire State Building.

We expect to complete the job in three years. We are reviewing the design studies and expect to request bids this summer on an architectural and engineering contract, to be awarded in the fall. The construction contract is to be awarded in early 1963, so that the facility will be ready for the first launching of the Advanced Saturn in 1965.

All together, the President has requested about 819 million dollars for construction of facilities during the Fiscal Year that begins July 1. There are projects throughout the country, at all NASA centers. For example, at the Lewis Research Center in Cleveland, we plan to construct a large vacuum chamber in which we can test space propulsion engines, such as ion and plasma rockets, powered by a nuclear reactor. At a new center we have established near the Atomic Energy Commission site in Nevada, we propose to develop an extensive plant for work with the AEC on the nuclear rocket.

In conclusion, let me emphasize that the space program is not the exclusive province of any one agency of the Government. NASA cooperates with, and depends on a number of departments and agencies. Our joint efforts are coordinated at the highest level by the National Aeronautics and Space Council, headed by the Vice President.

Nor can the job be carried out by Government alone. In President Kennedy's budget request for next year, 92 cents out of every NASA dollar would be spent on contracts with industry, universities, and other private organizations.

Participation in our National Space Program is very broad. Let me take the forthcoming orbital flight of Astronaut Scott Carpenter for an example. A few hundred must be on the job at Cape Canaveral. At present, there are about 1,500 in the NASA Manned Spacecraft Center, where Project Mercury was conceived, and where dedicated people worked for three years to make it a success. Thousands of others in the military services and throughout NASA support the operation and provide basic knowledge and technological back-up. There are many thousands of others employed by the major contractors and more than 4,000 sub-contractors and suppliers. But even beyond the direct and in-direct participants and the contractors is the magnificent support that has been forthcoming from Congress for the National Space Program, which reflects, in turn, the enthusiasm of the American people for this great new adventure of mankind.

A year ago, in his message to the Congress, President Kennedy observed that our national program does not merely involve one man going to the moon. "It will be an entire nation," the President declared. "For all of must work to put him there."

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